Appendix H3-1

Summary of the OU 10-04 ERA Sampling, Analysis, and Risk Assessment Results

CONTENTS

FIGURES

TABLES

Appendix H3-1

Summary of the OU 10-04 ERA Sampling, Analysis, and Risk Assessment Results

H3-1. SUMMARY OF THE OU 10-04 ERA SAMPLING

Sampling to support the OU 10-04 ERA was conducted in 1997 and again in 2000. The results of those sampling activities are presented below. Summary statistics for the OU 10-04 ERA sampling are presented in this Appendix.

H3-1.1.1 1997 Soil, Biota, Sediment, Surface Water

Ecological investigations in 1997 included sampling for chemical analysis and biological surveys. The results of the biological surveys are presented in Appendix H7. Surface soil and biota collected in 1997 were analyzed for selected metals and radionuclides in 1997 (and 1998) to support the ERA. The samples were collected in the area of INTEC (formerly Chemical Processing Plant (CPP)) plume and an offsite reference area (see Figures D1-4.1, and D1-4-2 of the OU 10-04 Work Plan, respectively [DOE/ID-10554, 1999]).

Due to elevated detection limits for some analytes in soil, archived 1997 soil samples were also analyzed in 1999 for metals and radionuclides. The soil samples were collected at the intervals shown below in Table H3-1a. The summary statistics for the archived soils are located in this Appendix as well.

Biota collection in 1997 consisted of 5 samples each at the onsite and offsite locations, and included deer mice (*Peromyscus maniculatus*), Nuttall's cottontail (*Sylvilagus nuttallii*), crested wheatgrass (*Agropyron cristatum*), Wyoming big sagebrush (*Artemisia tridentata, spp. wyomingensis*), beetles (*Eleodes* spp), and grasshoppers (family Acrididae). Where possible, the biotic samples were co-located with the soil samples. Field duplicates were collected for soil, vegetation, deer mice, and invertebrates on a limited basis due to lack of material available for collection. Upon collection, all samples were double-bagged, frozen, and stored under chain of custody until shipped to the laboratories. None of the samples were washed and the mammals were processed whole body including fur, legs, and ears.

In addition, two sediment and surface water samples were collected from the Industrial Waste Pond at ANL-W and analyzed for radionuclides and metals.

Summary statistics for all 1997 samples are presented in this Appendix of this report. Appendix H3 also provides the complete results of the soil and biota samples.

Summary statistics were generated for all data sets based on the assumption that all populations were normally distributed and no distribution testing was performed. Population distribution testing with small sample sizes such as 5 (or 6) lacks sufficient power to detect a significant difference in many instances, and represents a high degree of uncertainty. For this reason, as a conservative measure, only maximum concentrations were used for the evaluation of the field results. The summary statistics were calculated only on primary sample results and no rejected data were included. Field duplicate results were not averaged with the primary sample results and QC data were not included. Non-detected values were incorporated at one-half the detection limit. Negative radionuclide concentrations were not included in the evaluation.

H3-1.1.2 June 2000 Soil and Biota Sampling

A limited sampling effort was conducted in June 2000 at the BORAX area according to the Field Sampling Plan (INEEL/EXT-99-01053). This effort included collecting both soil and biota samples at the BORAX area. The purposes of this effort were to assess the performance of the cap at the BORAX-0I site pertaining to the potential for small mammal intrusion, and to establish potential biotic uptake. Summary statistics for the BORAX soil and biota sampling are provided in Appendix C.

Table H3-1a. Depth Intervals for 1997 Soil Samples for the OU 10-04 ERA.

Year	Interval (feet)	CPP Plume-Number of Samples	Reference Area-Number of Samples
1997 (archive)	0 - 0.5	5	5
Analyzed in 1999	0.5 – 1	2	—
	0.5 - 1.1	1	—
	0.5 - 1.5	1	1
	0.5 – 2	1	4
1997	0 - 0.5	—	—
Analyzed in 1997	0.5 – 1	—	—
	0.5 - 1.1	—	—
	0.5 - 1.5	—	—
	0.5 – 2	—	—
	0 – 2	6 (5 + 1 field duplicate)	6 (5 + 1 field duplicate)

H3-1.1.2.1 1999 Onion Sampling. Wild onion samples were collected in 1999 for informational purposes to support the Native American scenario and were not strictly associated with the OU 10-04 ERA. These samples were analyzed for nitroaromatics, metals, and radionuclides. Sample locations were onsite at INTEC and the Fire Station areas as well as the offsite reference area (i.e., two of the same sample locations as those sampled in 1997). The summary statistics for the onion samples are located in this Appendix.

H3-1.2 Analysis of the OU 10-04 ERA Sampling

In this section of the ERA process, contaminant concentrations in environmental media are evaluated to determine the potential exposure to ecological receptors. The maximum detected concentrations of the 1997 and 2000 ecological soil samples were compared to the INEEL background results (Table H3-1b). Both the 1997 CPP and 2000 BORAX results were also compared to the 1997 reference area results for soil and biota. The results of these comparisons are provided below. In addition, the ERA sampling results were evaluated using the screening process discussed in Appendix F as a means to identify COPCs as well as compare the reference area soil results to the EBSLs. Exposure point concentrations, risk assessment parameters, and results for the OU 10-04 ERA sampling are presented in this Appendix.

H3-1.2.1.1 1997 Soil Results (0-2 ft). Soil sample results for the samples collected and analyzed in 1997 at CPP and the reference area represented 0-2 ft composites and were co-located with vegetation and small mammal transects where possible. The maximum concentrations were screened for preliminary COPCs following the approach used in Section 4 of this OU 10-04 RI/FS report. See results and summary statistics in this appendix. Only boron (9.2 mg/kg) and strontium (72.3 mg/kg) maximum concentrations at the CPP plume exceeded the INEEL background or EBSL if a screening value was available. Both CPP maximum concentrations for boron and strontium exceeded EBSLs and no background values were available for comparison. Arsenic, boron, manganese, and strontium levels at the reference area exceeded either an INEEL background or an EBSL value. The reference area arsenic concentration (maximum value of 6.3 mg/kg) only slightly exceeded the INEEL background level of 5.8 mg/kg. There was no INEEL boron background for comparison against the reference area maximum value of 17.3 mg/kg. The reference area manganese maximum (506 mg/kg) only slightly exceeded the INEEL background value of 490 mg/kg. There was no INEEL background strontium value for comparison; however the reference area maximum strontium concentration of 126 mg/kg exceeded the EBSL (5.91 mg/kg) which suggests that the strontium EBSLs may be overly conservative. The boron EBSL may also be overly conservative since the reference area maximum concentration exceeded the EBSL.

Table H3-1b. Comparison of the 1997 ERA Soil Sampling Maximum Concentrations to the INEEL Background Data Set.

Analyte	INEEL Background 95/95% UTL concentration, mg/kg, composite	CPP Area (1997: 0-2ft) Maximum concentration, mg/kg	Reference Area (1997: 0-2ft) Maximum concentration, mg/kg
Aluminum	16000	14200	15900
Antimony	4.8	ND (@5.2)	ND (@5.4)
Arsenic	5.8	4.4	6.3
Barium	300	246	238
Beryllium	1.8	0.8	0.85
Boron	NA	9.2	17.3
Cadmium	2.2	0.75	0.53
Chromium	33	25.8	17.5
Cobalt	11	8.4	7.9
Copper	22	20.7	18.4
Lead	17	15.2	14.7
Magnesium	12000	10300	11000
Manganese	490	399	506
Mercury	0.05	0.05	0.08
Molybdenum	NA	ND (@1)	ND (@1.1)
Nickel	35	33	20.3
Selenium	0.22	ND (@0.26)	ND (@0.27)
Silver	ND [a]	ND (@0.52)	ND (@0.54)
Strontium	NA [b]	72.3	126
Thallium	0.43	ND (@0.11)	0.24
Vanadium	45	25.1	22.6
Zinc	150	136	68.8

[a]ND - not detected

[b]NA - not analyzed

Note—. Any silver detect is considered above background.

mg/kg – milligram per kilogram

INEEL Background Data Source: Rood et al, 1996.

For the ERA screening on the 1997 data, the maximum concentrations represent the exposure point concentrations (EPCs). The EPCs for each analyte in soil are presented as the maximum concentrations in the summary statistics (Appendix H3). Table H3-1c presents the screening for reference area soil samples (0-2 ft) and Table H3-1d presents the CPP screening results (0-2 ft).

At the reference area, arsenic (6.3 mg/kg), boron (17.3 mg/kg), manganese (506 mg/kg), and strontium (126 mg/kg) were retained as potential contaminants when compared to the INEEL background or EBSLs. However, since these maxima were obtained at an offsite location, presumed uncontaminated by INEEL activities, these values should be considered when comparing other site concentrations to establish contamination. Boron (9.2 mg/kg) and strontium (72.3 mg/kg) were retained as potential contaminants at the CPP area since no INEEL background values were available for these metals and they exceeded their respective EBSLs. Both of the CPP maxima were below the reference area maxima; therefore, they should not be retained as potential COPCs. Since the maximum concentrations for the CPP are all less than background or the reference area, or do not exceed the EBSLs, this supports the assertion that contamination has not migrated off the site. Since the predominant wind direction on the INEEL is from southwest to northeast, the possibility that the reference area results might have been influenced by Site contamination is low (i.e., the reference area lies to the southwest of the INEEL).

H3-1.2.1.2 1997 Deer Mice Results. The deer mice represented whole body composites from typically 3 individuals. For most analytes, there were 6 sample results (5 plus one duplicate) for both the reference area and the CPP (see Appendix H3). One composite field duplicate for each the CPP plume and reference area was analyzed. Analytes included selected radionuclides, metals, percent moisture, and lipids. Gamma scans and gross alpha/beta spectroscopy were also performed for initial screening purposes. Samples were submitted for alpha spectroscopy only if there were significant detects from either the alpha/beta or gamma scans. Cs-137 was detected in 3 of 3 deer mice samples at the CPP plume with a maximum concentration of 0.39 pCi/g, and Sr-90 was detected in all six CPP and reference area samples with a maximum concentration of 0.72 pCi/g (CPP). There were no detects of antimony, arsenic, silver, or thallium in deer mice at the CPP plume, whereas cadmium was detected in 2 of 6 samples with a maximum concentration of 0.02 mg/kg. Cadmium was not detected in deer mice from the reference area. Both lead and mercury were detected in 4 of 6 CPP deer mice composite samples with maximum concentrations of 0.37 mg/kg and 0.01 mg/kg, respectively. Lead was not detected in deer mice from the reference area; however, mercury was detected in all six reference area samples (5 + 1 field duplicate) with a maximum concentration of 0.01mg/kg.

Results for U-234, U-238, and Cs-137 were available for only one sample at the reference area with maximum concentrations of 0.006 pCi/g, 0.005 pCi/g, and 0.12 pCi/g, respectively. Sr-90 was detected in all 6 samples at the reference area with a maximum concentration of 0.178 pCi/g. There were no detects of antimony, cadmium, silver, or thallium in deer mice at the reference area; however, arsenic was detected in one reference area sample with a maximum value of 0.74 mg/kg. Other metal concentrations appeared very similar between on-site and off-site.

For the evaluation of the ERA data, analyte maxima were compared between the reference area and the CPP (now called INTEC) plume and BORAX sites. Site-specific bioaccumulation factors (BAFs) for several metals and biota types were developed; however these BAFs were not incorporated into the food ingestion pathway. This decision was based upon a final review of the site-specific results when compared to the literature BAFs.

Table H3-1c. Soil Contaminant Screening Process for the Reference Area - 1997 Soil Samples (0-2 ft).

		Step 1		Step 2	Step 3		Step 4		Site COPC?
Detected Contaminants	Max Source Concentration (mg/kg or pCi/g)	INEEL Background Concentration (mg/kg or pCi/g)	Max Concentration > background?	Nontoxic Metal?	Region IX/III RBC (mg/kg or pCi/g)	Max Concentration > RBC?	INEEL EBSL (mg/kg or pCi/g)	Max Concentration > EBSL?	ERA
Am-241	0.26	1.10E-02	Yes	No	2.90E+00	No	1.78E+01	No	No
Cs-137	0.10	8.20E-01	No	No	2.30E-01	No	4.95E+03	No	No
U-235	0.07	NA	NA	No	1.30E-01	No	2.27E+01	No	No
U-234	0.82	1.44E+00	No	No	1.80E+01	No	2.05E+01	No	No
U-238	0.88	1.40E+00	No	No	6.70E-01	Yes	2.32E+01	No	No
Aluminum	15900	1.60E+04	No	Yes	7.61E+04	No	8.50E+00	Yes	No
Arsenic	6.30	5.80E+00	Yes	No	3.90E-01	Yes	8.44E-01	Yes	**Yes**
Barium	238	3.00E+02	No	No	5.48E+03	No	1.10E+01	Yes	No
Beryllium	0.85	1.80E+00	No	No	1.56E+02	No	7.14E-01	Yes	No
Boron	17.3	NA	NA	No	5.50E+03	No	5.00E-01	Yes	**Yes**
Cadmium	0.53	2.20E+00	No	No	3.90E+01	No	2.36E-03	Yes	No
Chromium	17.5	3.30E+01	No	No	2.10E+02	No	1.00E+00	Yes	No
Cobalt	7.90	1.10E+01	No	No	4.69E+03	No	4.27E-01	Yes	No
Copper	18.4	2.20E+01	No	No	2.90E+03	No	2.11E+00	Yes	No
Lead	14.7	1.70E+01	No	No	4.00E+02	No	9.94E-01	Yes	No
Manganese	506	4.90E+02	Yes	No	1.60E+03	No	1.05E+01	Yes	**Yes**
Mercury	0.08	5.00E-02	Yes	No	6.10E+00	No	3.00E-01	No	No
Nickel	20.3	3.50E+01	No	No	1.56E+03	No	3.00E+01	No	No
Strontium	126	NA	NA	No	4.69E+04	No	5.91E+00	Yes	**Yes**
Thallium	0.24	4.30E-01	No	No	5.48E+00	No	1.01E-01	Yes	No
Vanadium	22.6	4.50E+01	No	No	5.48E+02	No	1.49E+00	Yes	No
Zinc	68.8	1.50E+02	No	No	2.35E+04	No	3.29E+00	Yes	No
Magnesium	11000	1.20E+04	No	Yes	NO RBC	No RBC	No EBSL	No EBSL	No

Table H3-1c. (continued).

Sodium	1920	3.20E+02	Yes	Yes	NO RBC	No RBC	No EBSL	No EBSL	No
Calcium	65900	2.40E+04	Yes	Yes	NO RBC	No RBC	No EBSL	No EBSL	No
Iron	16700	2.40E+04	No	Yes	2.35E+04	No	No EBSL	No EBSL	No
Potassium	3310	4.30E+03	No	Yes	NO RBC	No RBC	No EBSL	No EBSL	No

Note: Analytes for which there were no detected concentrations were not included in the soil screening process. The summary statistics for the complete data are provided in this Appendix.

"NA" in Step 1 indicates that a background value is not available.

"No RBC" indicates that an EPA Region IX or III risk-based Concentration based on residential soil ingestion is not available.

"No EBSL" indicates that an INEEL ecologically-based screening level is not available.

Table H3-1d. Soil Contaminant Screening Process for the CPP Plume – 1997 Soil Samples (0-2 ft).

		Step 1		Step 2	Step 3		Step 4		Site COPC?
Detected Contaminants	Max Source Concentration (mg/kg or pCi/g)	INEEL Background Concentration (mg/kg or pCi/g)	Max Concentration > background?	Nontoxic Metal?	Region IX/III RBC (mg/kg or pCi/g)	Max Concentration > RBC?	INEEL EBSL (mg/kg or pCi/g)	Max Concentration > EBSL?	ERA
Am-241	7.19E-02	1.10E-02	Yes	No	2.90E+00	No	1.78E+01	No	No
Cs-137	2.88E+00	8.20E-01	Yes	No	2.30E-01	Yes	4.95E+03	No	No
Pu-238	8.05E-02	4.90E-03	Yes	No	6.70E+00	No	1.78E+01	No	No
Pu-239	2.14E-02	1.00E-01	No	No	2.50E+00	No	1.89E+01	No	No
Sr-90	1.05E+00	4.90E-01	Yes	No	2.30E+02	No	3.34E+03	No	No
U-234	1.14E+00	1.44E+00	No	No	1.80E+01	No	2.05E+01	No	No
U-235	4.96E-02	NA	NA	No	1.30E-01	No	2.27E+01	No	No
U-238	1.08E+00	1.40E+00	No	No	6.70E-01	Yes	2.32E+01	No	No
Aluminum	1.42E+04	1.60E+04	No	Yes	7.61E+04	No	8.50E+00	Yes	No
Arsenic	4.40E+00	5.80E+00	No	No	3.90E-01	Yes	8.44E-01	Yes	No
Barium	2.46E+02	3.00E+02	No	No	5.48E+03	No	1.10E+01	Yes	No
Beryllium	7.80E-01	1.80E+00	No	No	1.56E+02	No	7.14E-01	Yes	No
Boron	9.20E+00	NA	NA	No	5.50E+03	No	5.00E-01	Yes	**Yes**
Cadmium	7.50E-01	2.20E+00	No	No	3.90E+01	No	2.36E-03	Yes	No
Calcium	2.68E+04	2.40E+04	Yes	Yes	NO RBC	No RBC	No EBSL	No EBSL	No
Chromium	2.58E+01	3.30E+01	No	No	2.10E+02	No	1.00E+00	Yes	No
Cobalt	8.40E+00	1.10E+01	No	No	4.69E+03	No	4.27E-01	Yes	No
Copper	2.07E+01	2.20E+01	No	No	2.90E+03	No	2.11E+00	Yes	No
Iron	1.89E+04	2.40E+04	No	Yes	2.35E+04	No	No EBSL	No EBSL	No
Lead	1.52E+01	1.70E+01	No	No	4.00E+02	No	9.94E-01	Yes	No
Magnesium	1.03E+04	1.20E+04	No	Yes	NO RBC	No RBC	No EBSL	No EBSL	No
Manganese	3.99E+02	4.90E+02	No	No	1.60E+03	No	1.05E+01	Yes	No
Mercury	5.00E-02	5.00E-02	Yes	No	6.10E+00	No	3.00E-01	No	No
Nickel	3.30E+01	3.50E+01	No	No	1.56E+03	No	3.00E+01	Yes	No
Potassium	2.42E+03	4.30E+03	No	Yes	NO RBC	No RBC	No EBSL	No EBSL	No
Sodium	4.72E+02	3.20E+02	Yes	Yes	NO RBC	No RBC	No EBSL	No EBSL	No
Strontium	7.23E+01	NA	NA	No	4.69E+04	No	5.91E+00	Yes	**Yes**

Table H3-1d. (continued).

Vanadium	2.51E+01	4.50E+01	No	No	5.48E+02	No	1.49E+00	Yes	No
Zinc	1.36E+02	1.50E+02	No	No	2.35E+04	No	3.29E+00	No	No

Note: Analytes for which there were no detected concentrations were not included in the soil screening process. The summary statistics for the complete data are provided in this Appendix.

"NA" in Step 1 indicates that a background value is not available.

"No RBC" indicates that an EPA Region IX or III risk-based Concentration based on residential soil ingestion is not available.

"No EBSL" indicates that an INEEL ecologically-based screening level is not available.

H3-1.2.1.3 1997 Cottontail Sampling. Cottontail tissue was analyzed as whole body and no compositing was necessary. For some analytes, there were results for five samples both at the reference area and CPP plume, whereas for other analytes, primarily radionuclides, there were from 1 to 5 sample results for each location. Refer to Appendix H3 for the summary statistics. There were very low detects of Cs-137, Sr-90, U-234, and U-238 in samples from both the reference area and the CPP plume. No detected value for any single radionuclide exceeded 0.5 pCi/g. In addition, there was a single Pu-239/240 detect (0.001 pCi/g) from the reference area. There were no detects of antimony, arsenic, cobalt, or thallium in the CPP samples. This was also true for the reference area samples; however, beryllium and mercury were also not detected. Aluminum concentrations in samples from CPP were somewhat elevated with respect to the reference area. The remaining analyte concentrations appeared very similar between both locations.

For the evaluation of the ERA data, analyte maxima were compared between the reference area and the CPP plume and BORAX sites. The derivation of site-specific BAFs for each COPC to be incorporated into the food ingestion pathway will be evaluated after all data have been reviewed.

H3-1.2.1.4 1997 Sagebrush Sampling. Sagebrush samples were obtained by collecting new growth leafy material from several plants in the general area near the soil sample location and represented composited materials. There were five sample results for the reference area. One composite field duplicate for the CPP plume area and five primary samples were analyzed, which provided six sample results for that location. Refer to Appendix H3 for the summary statistics. Gamma spectroscopy results indicated no radionuclides in samples collected at the CPP area; however, there were gross beta results for all 6 samples with a maximum estimated value of 7.4 pCi/g. Results from the reference area were very similar, and only gross beta results had 100% detection frequency. There were no cobalt or silver detects in any sample. Antimony, beryllium, and thallium were also not detected in the reference samples; however, antimony and beryllium were detected in two CPP samples, and thallium in three samples at very low levels with no analyte concentration exceeding 0.02 mg/kg. Aluminum concentrations in samples from the CPP were somewhat elevated with respect to the reference area. The remaining analyte concentrations appeared very similar between both locations.

For the evaluation of the ERA data, analyte maxima were compared between the reference area and the CPP plume and BORAX sites. The derivation of site-specific BAFs for each COPC to be incorporated into the food ingestion pathway will be evaluated after all data have been reviewed and only as appropriate.

H3-1.2.1.5 1997 Wheatgrass Sampling. For most analytes, there were 6 sample results (5 plus one duplicate) for both the reference area and the CPP area (see Appendix H3 for the summary statistics). Only non-specific radionuclide detections based on gross beta scans were observed at both the reference area and CPP plume. There were no detects of cadmium, cobalt, lead, or thallium in CPP samples. This was also observed at the reference area; however, there were also no detects of beryllium or copper at the reference area. All antimony results were rejected due to poor precision between duplicate injections for the analytical method based on the database flags. With the exceptions of beryllium and silver where these analytes were detected in one sample at CPP, the remaining analyte concentrations appeared very similar between both locations.

For the evaluation of the ERA data, analyte maxima were compared between the reference area and the CPP plume and BORAX sites. The derivation of site-specific BAFs for each COPC to be incorporated into the food ingestion pathway will be evaluated after all data have been reviewed.

H3-1.2.1.6 1997 Grasshopper Sampling. Five grasshopper samples representing composites of several individuals were collected at both the reference area and the CPP plume area. Due to the lack of sample material, no duplicates were collected. Refer to Appendix H3 for the summary statistics. There were no antimony detects in the CPP plume or reference area samples. Barium was also not detected in any reference area sample and in only 1 of 5 CPP samples. Mercury was detected in all CPP samples but only in 1 reference area sample. Cobalt was detected in only 1 CPP sample but all reference area samples had cobalt. As with the other biota results, aluminum results showed the highest concentrations, and analyte concentrations for aluminum and the remaining metals were similar between both study areas. Silver was detected in all samples with a maximum concentration of 0.03 mg/kg. Sr-90 was detected in the single CPP sample result for that analyte. There were gross beta detects for all samples at both areas, and no gross alpha results in any sample.

For the evaluation of the ERA data, analyte maxima were compared between the reference area and the CPP plume and BORAX sites. The derivation of site-specific BAFs for each COPC to be incorporated into the food ingestion pathway will be evaluated after all data have been reviewed.

H3-1.2.1.7 1997 Beetle Sampling. Sr-90 results were available for only one sample at each study location and both results were considered positive detects. U-234 and U-238 were detected at low levels in 3 of 5 reference area samples but not detected in the CPP samples. The detection frequency was 100% for gross alpha/beta for the reference area samples and 100% for the CPP area (beta only). Only one in 5 CPP samples was considered a true positive result for gross alpha. There were no beryllium or thallium detects in the CPP samples and no antimony or lead in the reference area samples. Antimony was only detected in one sample and lead in 2 of 5 CPP samples. Silver was detected in all reference area samples but in only 2 of 5 CPP samples.

For the initial evaluation of the ERA data, analyte maxima were compared between the reference area and the CPP plume and BORAX sites. The derivation of site-specific BAFs for each COPC to be incorporated into the food ingestion pathway will be evaluated after all data have been reviewed.

H3-1.2.1.8 Sediment and Surface Water (Industrial Waste Pond). Summary statistics for the two sediment and surface water samples collected at the Industrial Waste Pond at TRA are provided in this Appendix of this report. Appendix H3 provides the complete results for these samples. The maxima were compared to available sediment and surface water criteria where possible. No radionuclides exceeded recommended radiological screening benchmarks (ORNL 1998). The following maximum metals concentrations exceeded a recommended sediment quality criterion or guideline:

Cadmium (2.3 mg/kg) vs 0.6 mg/kg

Chromium (2150 mg/kg) vs 37.3 mg/kg

Copper (43.1 mg/kg) vs 35.7 mg/kg

Mercury (0.9 mg/kg) vs 0.17 mg/kg

Silver (18.1 mg/kg) vs 0.5 mg/kg

Zinc (1,030 mg/kg) vs. 123 mg/kg.

The majority of the sediment quality criteria were freshwater threshold effects levels (TELs) from Smith et al, 1996. Tables H3-15 and H3-16 of this appendix summarize these data and provide greater detail on the sources of the sediment and water quality criteria and screening benchmarks. Only aluminum (415 ug/L) and lead (6.3 ug/L) concentrations in surface water exceeded water quality criteria 87 ug/L, and 2.5 ug/L, respectively; however aluminum is pH dependent and lead is hardness dependent. Without hardness and pH data, actual applicable criteria cannot be calculated. Thus, there is considerable uncertainty whether the criteria were actually exceeded. The sediment and surface water quality criteria were developed for truly aquatic organisms (i.e., sediment criteria for benthos, and surface water criteria for fish and other aquatic organisms). However, there are no other benchmarks for comparison, which might serve as an indicator or aquatic habitat quality for ecological receptors utilizing permitted waste ponds. The IWP is an active, RCRA-permitted facility; however, terrestrial and aquatic receptors (particularly benthos) utilizing this site for drinking water may be at risk from elevated metals concentrations if sediment ingestion also occurs.

H3-1.2.1.9 1997 Archive Soils Analyzed in 1999. Due to several elevated detection limits associated with the analysis of metals in soil for the 1997 ecological samples, selected 1997 samples were analyzed again in 1999 for inorganics and radionuclides.

The 1997 archive soil samples analyzed in 1999 (Table H3-1a, above) were subsequently segregated into two groups, 0-0.5 ft and 0.5-2 ft, because the field team was unable to complete discrete subsurface depth intervals at the INTEC locations due to shallow soil depths and cobble.

Summary statistics for the 1997 archived soil samples are provided in this Appendix of this report. Appendix H3 also provides the complete results of these samples. Further evaluation of the archived soils may be warranted following the submission of this version of the report.

H3-1.2.1.10 1999 Onion Sampling Results. Wild onion samples were collected at locations both onsite and offsite to address Native American concerns. The Shoshone-Bannock tribe utilizes the onion plants in a variety of ways including textiles and food. Samples were collected near the Fire Station (See Section 12), and at an area previously sampled in 1997 near INTEC. Two off-site reference areas previously sampled in 1997 were also sampled. These locations were co-located with the 1997 sampling locations at the reference area and onsite. All samples were analyzed for metals, radionuclides, and nitroaromatics. The sample results and summary statistics for these samples are presented in this Appendix. Due to the low number of overall samples collected, duplicate analyses were not averaged.

The results showed that traces of radionuclides and metals were present in the onions collected from both onsite and offsite locations. However, the detected radionuclides and metals were those present in the soil naturally, such as U-234, U-238, aluminum, and potassium, and there was no difference between the on- and offsite concentrations. The data also showed that all the nitroaromatics results were below detectable limits. Based on these results, no significant risk is expected.

No nitroaromatics were detected in any onion sample collected either onsite or offsite. Radionuclides detected in on-site onion samples included Am-241, Sr-90, U-234, U-238, and gross beta. Aluminum, barium, cadmium, copper, iron, magnesium, manganese, potassium, sodium, vanadium, and zinc were detected in all onsite samples. Radionuclides detected in reference area samples included Am-241, U-234, U-238, U-235, and gross beta. The same metals detected in the onsite samples were also detected in reference area onion samples. None of the analytical data appeared remarkable based on concentrations or analytes.

H3-1.2.1.11 BORAX 2000 Sampling and Analysis Results. Five surface (0-6 in.) and five subsurface (6-12 in.) soils were collected at various locations at the BORAX site. Sagebrush samples were collected in positions co-located with the soil samples. Small mammals including deer mice, kangaroo rats, and cottontail rabbits were also harvested for chemical analysis. Upon collection, all samples were double-bagged, frozen, and stored under chain of custody until shipped to the laboratories. None of the samples were washed and the mammals were processed whole body including fur, legs, and ears. All samples were analyzed for metals and radionuclides. Both surface and subsurface soil samples were screened as in Appendix F. Those results are provided in Section 7 and the summary statistics are presented in Appendix C.

Soils. Strontium (138 mg/kg) was retained as a potential contaminant following the screening process. No radionuclides exceeded the INEEL background values or EBSLs. Strontium only slightly exceeded the reference area maximum (126 mg/kg) and is likely within environmental ranges for this metal (Appendix C). There do not appear to be any contaminants in either the subsurface or surface soil at the BORAX areas sampled.

Biota. Summary statistics for the biota samples are presented in Appendix C. The results were not used to calculate site-specific BAFs because the data were collected primarily to evaluate movement of radionuclides from under the soil cap to the environment, and also because no reference results were obtained and the data were collected over 3 years later than the 1997 data.

H3-1.3 Analysis of Exposures

The exposure analysis includes the calculation of intakes for the ecological receptors. An exposure point concentration (EPC) is determined for each contaminant and the amount of contaminant ingested is estimated by using exposure parameters. These parameters include body weights, media ingestion rates, dietary composition, uptake factors (e.g., BAFs and PUFs), and factors which incorporate time spent in contaminated areas relative to home range (e.g., a site use factor, SUF). These calculations result in estimated doses (i.e., intakes) to the ecological receptors. From plants, the EPC represents the exposure due to direct soil contact. Exposures to soil invertebrates were not evaluated. For the OU 10-04 ERA sampling including all data from 1997, 1999, and 2000 discussed in this section, exposure point concentrations (EPCs) were represented by the maximum concentration for each contaminant.

H3-1.3.1.1 Analysis of Exposures for the 1997 ERA Sampling. The maximum soil concentration for each COPC at each location was used to represent the EPC. Since the biota data collected in 1997 and 2000 have not undergone a thorough evaluation, site-specific bioaccumulation factors were not developed with which to estimate movement through the food chain. Instead, BAFs and PUFs were obtained from literature sources and are documented in Appendix D of the OU 10-04 Workplan (DOE-ID 1999). The exposure factors for the functional groups, as well as the individual ecological receptors are also provided for in Appendix D of the OU 10-04 Workplan. The OU 10-04 workplan also documents intake equations for radionuclides and non-radionuclides. These intakes for the functional groups and key receptors for the CPP plume area and the reference area were also used.

H3-1.3.1.2 Analysis of Exposures for the 2000 BORAX ERA Sampling. The same approach as discussed above for the 1997 ERA sampling results was used to estimate intakes for the ecological receptors at the BORAX area. None of the biota data were used to develop site-specific BAFs (or PUFs) as discussed previously. The intake equations are presented in Appendix D of the OU 10-04 Work Plan (DOE-ID 1999) and the intakes presented in this appendix.

H3-1.3.1.3 Analysis of Exposures for the 1999 Wild Onion Sampling. The calculation of exposure estimates for any ecological receptor using the wild onion data as a dietary item was deemed unnecessary since these data were not actually collected to support the ERA. Since no wildlife receptor was expected to consume wild onion matter, no attempt was made to calculate PUFs with these data.

H3-1.4 Risk Characterization for the OU 10-04 ERA Sampling

In a typical quantitative risk assessment, risk is estimated by comparing the results of the exposure analysis and ecological response analysis to obtain hazard quotients (HQs). The HQs are summed as appropriate to obtain hazard indices (HIs). HIs or HQs exceeding one for an ecological receptor may indicate the potential for risk. The risk assessment results of the OU 10-04 ERA are presented in this Appendix.

The HQs and HIs from the offsite reference area and the INEEL background provide a measure of inherent risk. High levels of naturally occurring inorganics result in high indices of inherent risk. HIs based on the soil pathway for the CPP plume and BORAX area were compared to HIs calculated from the reference area and the INEEL background. The ratio of HIs between contaminated sites and the reference area is a measure of the relative risk. This indicates the proportion of risk due to site-related activities.

This section provides a description and results of the risk calculations. The risk calculation descriptions include the HQ method that was used to determine risk for each terrestrial pathway for each representative species. This also includes a comparison of EPCs to various media screening concentrations also expressed as HQs.

H3-1.4.1.1 OU 10-04 ERA Sampling Risk Calculations. The integration of toxicity and exposure information is used to predict possible adverse effects to ecological receptors. The HQ method is used to screen sites when potential adverse effects to ecological receptors occur. It provides an evaluation of the potential environmental effect of a given COPC. The method compares estimates of animal intake values to the TRV; this comparison is expressed as the HQ (i.e., the intake divided by the TRV). For plants, the soil EPC is divided by the plant TRV to obtain an HQ. If the HQ is greater than 1, a receptor has a potential for adverse effects due to exposure to a contaminant via a specific exposure pathway. Where possible, based on the availability of site data, exposure parameters, and toxicity information, HQ values were determined for each COPC and exposure pathway potentially affecting the selected OU 10-04 ERA receptors. The HQ values were calculated using the following equation:

$$HQ = \frac{Intake\ of\ COPC\ \ by\ Receptor}{TRV\ \ for\ COPC\ \ \ for\ Receptor}$$

where

HQ = The *hazard quotient* calculated for a given exposure pathway

A total risk (hazard index or HI) for each COPC due to all pathway exposures at a site is usually calculated for each receptor as shown.

$$HI_{total} = (HQ_{soil\ ingestion} + HQ_{dietary\ ingestion} + \ldots HQ_n)$$

where

HI_{total} = Sum of all HQs from all COPCs for a receptor by location for all pathways

$HQ_{soil\ ingestion}$ = Sum of all HQs for all COPCs for a receptor by location for the soil ingestion pathway

$HQ_{dietary\ ingestion}$ = Sum of all HQs for all COPCs for a receptor by location for the dietary ingestion pathway

Additional pathways might include dermal absorption and inhalation. For the OU 10-04 ERA, the pathways were limited to soil and dietary ingestion.

$$HI = \sum_{j}^{m} HQ$$

where

HI = Sum of all *HQ* values for a receptor by location, for pathway *j* through the *m*th pathway

m = Number of pathways assessed for the receptor at a location

HI values exceeding 1 indicate that the receptor being assessed has a potential for adverse effects resulting from exposure to a COPC via one or more pathways at a given site, and/or due to exposure to one or more COPCs. It should be noted that a single chemical or pathway may be the driving force for an HI for a key species at a site.

HI values exceeding 1 indicate potential risk because the exposure level exceeds the effects level. Such values do not necessarily indicate that an effect will occur, only that a lower threshold has been exceeded based on the exposure assumptions used in the model. Since the HI value is the sum of HQ values that are themselves conservative, the HI values are also extremely conservative. Because HIs represent the summation of HQs for all analytes to facilitate comparison of one site to another, and because all toxicological effects are not additive, it is recommended that risk decisions be made on the HQ and not the HI.

The HI, as an evaluation of a measurement endpoint, provides some insight into general effects on individual plant and animal reproduction and/or survival in the local population. It is assumed that if effects are judged insignificant for the average individual receptor, they will be considered insignificant at the population level. However, if risks are present at the individual receptor level, risks may or may not be important at the population level.

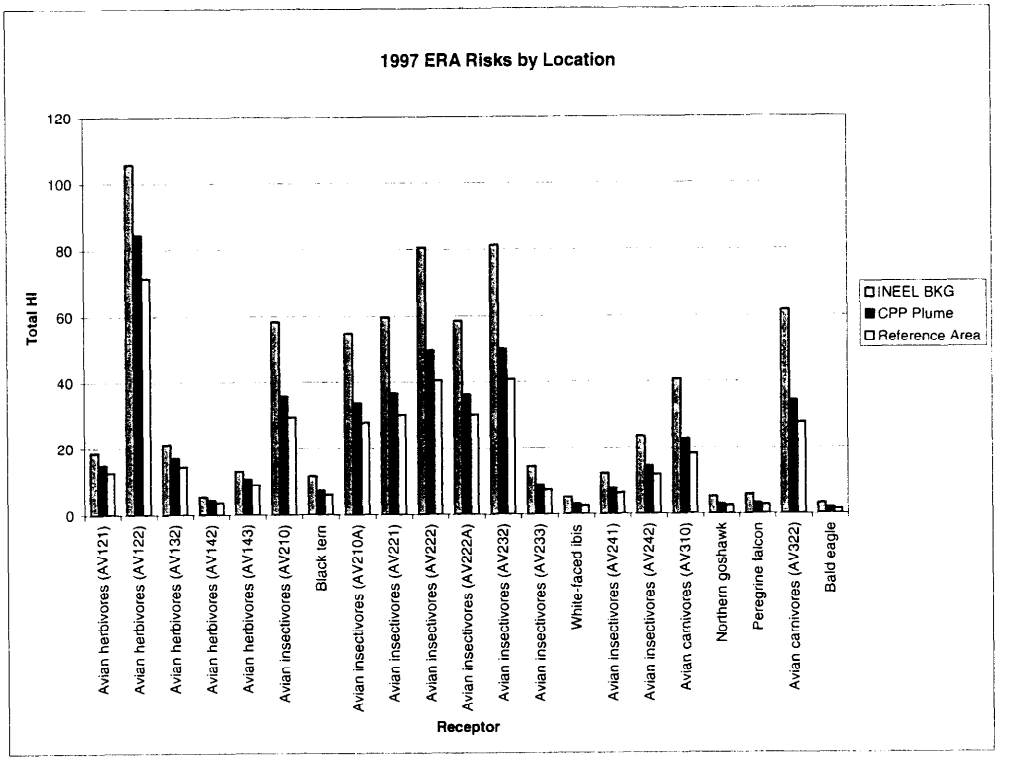
HQs calculated for metals and radionuclides detected in soil at the reference area, BORAX, CPP plume, and the INEEL background based on the 1997 and 2000 sampling events are presented in this Appendix. Only those metals and radionuclides common to all data sets were included in the risk calculations in order to provide an equitable evaluation of the results between locations. The first set of calculations incorporated the receptors as functional groups whereas the second set of risk results includes the new set of ecological receptors for the OU 10-04 ERA.

H3-1.4.1.2 Risk Estimates from the 1997 ERA Soil and Biota Sampling. The 1997 soil results for metals were evaluated from three sampling locations: 1) an offsite reference area, 2) the CPP plume area, and 3) an INEEL background. The EPCs based on the maximum detected concentrations for metals and radionuclides common to all three data sets were compared to the appropriate TRVs. Appendix H3 includes the EPCs, intakes, HQs, and HIs for each receptor for both the functional groups and new revised receptor list.

The biota data collected in 1997 were subsequently reviewed to consider replacing literature-based BAFs/PUFs for the dietary ingestion pathways. Upon further evaluation as discussed in Section 17, it was deemed that those BAFs calculated from the 1997 data would not be used in lieu of literature values. The following charts (Figure H3-1) show the total HIs from the three locations for the functional group receptors. Figure H3-2 shows the total HIs based on the *current OU 10-04 receptor* list for the reference area, CPP plume, and INEEL background.

The dimensions of the INEEL background area, as a conservative measure, were assumed to be equal to 1,920 hectares (3 sections) which was the approximate size of the offsite reference area. As shown in Tables H3-1e and H3-1f, the INEEL background contributed greater total risks than the presumed contaminated on-site CPP area ((e.g., bald eagle, a T/E species). For all functional groups, the INEEL background data set produced risks greater than or comparable to the reference area and the CPP plume area. Since the contributions from radionuclides to the risk estimates were negligible, the figures and tables include only risks from metals. Tables H3-1e and H3-1f provide the total HIs which represent the values used to generate Figures H3-1 and H3-2.

H3-1.4.1.3 Risk Estimates from the 2000 BORAX Soil and Biota Sampling. The biota data collected in 2000 at the BORAX site were reviewed and the decision was made to use the literature-based BAFs/PUFs for the ingestion pathways. Although only boron and strontium in soil remained as COPCs following an initial screening against the INEEL background and EBSLs, the metals and radionuclide maximum concentrations were also evaluated for risks in the same manner as the reference area and INEEL background. As can be seen from the results below, the INEEL background risks are comparable to or greater than the risks estimated from either the reference area or the BORAX area. The INEEL background area, as a conservative measure, was assumed to be equal to 1,920 hectares (3 sections) which was the approximate size of the offsite reference area. Table H3-1g provides the total HIs, which represent the values used to generate Figure H3-3. Since the contributions from radionuclides to the risk estimates were negligible, the figures and tables include only risks from metals.



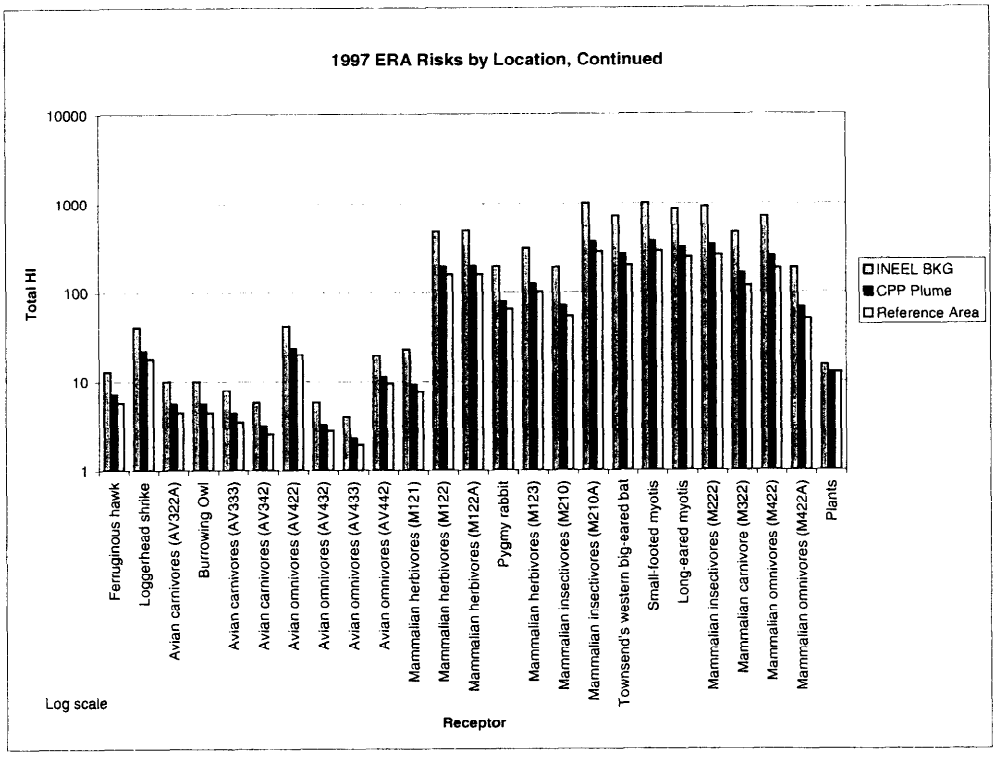


Figure H3-1. 1997 ERA risks by location.

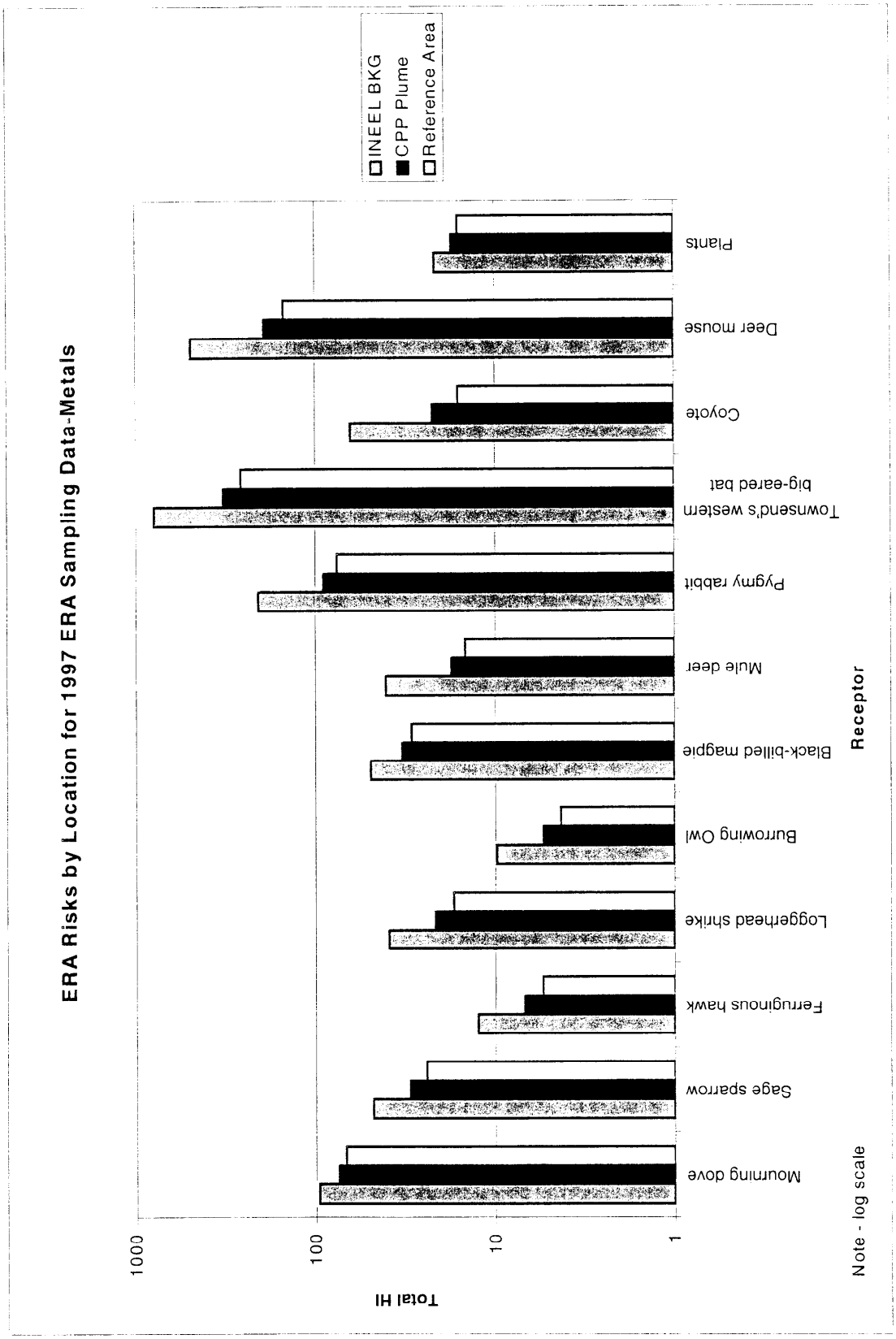


Figure H3-2. ERA risks by location for 1997 ERA sampling data—metals.

Table H3-1-e. Comparison of Total Hazard Indices for the INEEL Background, Reference Area, and CPP Plume (1997)-Functional Groups.

Functional Group List	INEEL BKG HI >= 1	CPP HI >=1	REF HI >=1
Avian herbivores (AV121)	18.7	14.9	12.6
Avian herbivores (AV122)	106	84.5	71.5
Avian herbivores (AV132)	21.4	17.1	14.4
Avian herbivores (AV142)	5.2	4.2	3.5
Avian herbivores (AV143)	13.0	10.7	8.8
Avian insectivores (AV210)	58.4	35.9	29.3
Black tern	11.7	7.2	5.9
Avian insectivores (AV210A)	54.9	33.8	27.7
Avian insectivores (AV221)	59.6	36.6	29.9
Avian insectivores (AV222)	80.6	49.5	40.5
Avian insectivores (AV222A)	58.6	36.3	29.8
Avian insectivores (AV232)	81.3	50.0	40.8
Avian insectivores (AV233)	14.4	8.8	7.2
White-faced ibis	4.8	3.0	2.4
Avian insectivores (AV241)	12.3	7.5	6.2
Avian insectivores (AV242)	23.5	14.5	11.8
Avian carnivores (AV310)	40.8	22.7	18.1
Northern goshawk	5.0	2.8	2.2
Peregrine falcon	5.6	3.1	2.5
Avian carnivores (AV322)	61.7	34.3	27.4
Bald eagle	**3.0**	**1.7**	**1.3**
Ferruginous hawk	12.9	7.2	5.7
Loggerhead shrike	40.1	22.3	17.8
Avian carnivores (AV322A)	10.0	5.6	4.5

Table H3-1e. (continued).

Functional Group List	INEEL BKG HI >= 1	CPP HI >=1	REF HI >=1
Burrowing Owl	10.0	5.6	4.5
Avian carnivores (AV333)	7.9	4.4	3.5
Avian carnivores (AV342)	5.8	3.2	2.6
Avian omnivores (AV422)	41.3	23.8	20.1
Avian omnivores (AV432)	5.8	3.3	2.8
Avian omnivores (AV433)	4.1	2.3	2.0
Avian omnivores (AV442)	19.5	11.2	9.5
Mammalian herbivores (M121)	23.0	9.3	7.6
Mammalian herbivores (M122)	487	196	162
Mammalian herbivores (M122A)	500	200	163
Pygmy rabbit	197	79.3	65.2
Mammalian herbivores (M123)	311	124	102
Mammalian insectivores (M210)	191	71	54
Mammalian insectivores (M210A)	1008	376	285
Townsend's western big-eared bat	712	266	201
Small-footed myotis	1015	378	286
Long-eared myotis	873	325	246
Mammalian insectivores (M222)	924	344	261
Mammalian carnivore (M322)	478	166	119
Mammalian omnivores (M422)	704	254	188
Mammalian omnivores (M422A)	190	68	50
Plants	15.2	12.6	12.7

Note: The following receptors could not be evaluated due to lack of TRVs and/or EPCs: amphibians (A232), reptilian insectivores (R222) sagebrush lizard, reptilian carnivores (R322), and trumpeter swan.

Table H3-1f. Comparison of Total Hazard Indices for the INEEL Background, Reference Area, and CPP Plume (1997)-Current Receptors.

Receptors	INEEL Background HI >= 1	CPP HI >=1	Reference HI >=1
Great Basin spadefoot toad	NA	NA	NA
Grasshoppers, beetles	NA	NA	NA
Sagebrush lizard	NA	NA	NA
Blue-winged teal	NA	NA	NA
Mourning dove	96.1	74.6	67.5
Sage sparrow	48.0	29.8	24.1
Ferruginous hawk	12.5	6.9	5.5
Loggerhead shrike	39.0	21.5	17.0
Burrowing Owl	9.8	5.4	4.3
Black-billed magpie	49.2	32.8	29.0
Mule deer	40.5	17.5	14.7
Pygmy rabbit	208	90.0	75.6
Townsend's western big-eared bat	790	327	260
Coyote	63.5	22.3	16.0
Deer mouse	491	193	150
Plants	21.5	17.4	15.9

NA = not

NA = not evaluated.

Table H3-1g. Comparison of Total Hazard Indices for the INEEL Background, Reference Area (1997), and BORAX (2000)-Current Receptors.

Receptors	INEEL Background HI >= 1	BORAX HI >=1	Reference HI >=1
Great Basin spadefoot toad	NA	NA	NA
Grasshoppers, beetles	NA	NA	NA
Sagebrush lizard	NA	NA	NA
Blue-winged teal	NA	NA	NA
Mourning dove	397	203	205
Sage sparrow	48.0	21.0	24.1
Ferruginous hawk	12.5	4.7	5.5
Loggerhead shrike	39.0	14.8	17.0
Burrowing Owl	9.8	3.7	4.3
Black-billed magpie	135	66.7	68.5
Mule deer	47.9	17.5	18.1
Pygmy rabbit	246	89.9	93.2
Townsend's western big-eared bat	790	268	260
Coyote	63.5	15.9	16.0
Deer mouse	510	159	158
Plants	122	62.0	62.0

NA = not evaluated

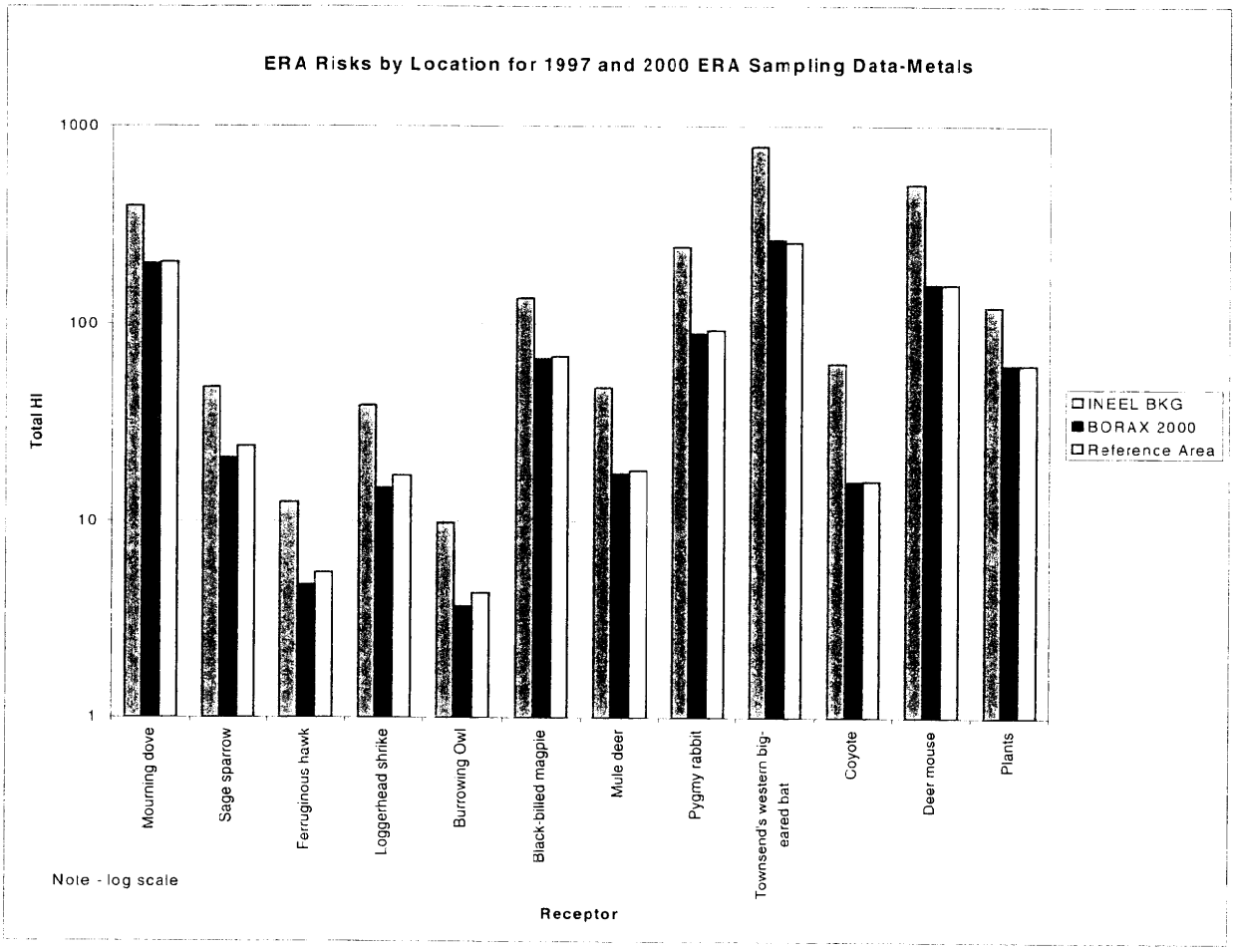


Figure H3-3. ERA risks by location for 1997 and 2000 ERA sampling data—metals.